losing or gaining electrons remained an atom of sodium, or whether the loss or gain of electrons did not cause it to change into some other element or elements. Having stated some theoretical arguments in favor of the possibility of transformation, he went on to describe some experiments bearing on the question. He first mentioned the transformation of radium emanation into helium, which had been amply established. He next referred to his experiments on the action of emanation on solution of copper sulphate and nitrate. Four experiments were made, and with each exactly similar duplicate experiments were tried in which no emanation was employed. A larger residue was obtained in each case from the emanation solutions than from the duplicates, and while the residues from the emanation solutions showed a faint trace of lithium, those from the duplicates failed to give spectroscopic evidence of the presence of that element. The fact of the experiments having been carried out in duplicate rendered inapplicable the criticism of Professor Hartley that accidental contamination with lithium was probable. As regards the alleged repetition of the experiments by Mme. Curie and Mlle. Gleditsch, who, using platinum vessels, obtained no greater residue and no trace of lithium, there were two possible replies—either the conditions were varied, or conceivably a trace of lithium from the glass vessel employed (which, however, had been tested for lithium with negative result) was dissolved in presence of emanation and copper but escaped solution in absence of copper or of emanation. A research on the action of emanation on solution of silver nitrate contained in a silica bulb yielded negative results, but he had stumbled across a case of apparent transformation while working in a totally different direction. On December 20, 1905, 270 grams of purified thorium nitrate were dissolved in about 300 c.c. of water, and the flask in which the solution was contained was repeatedly evacuated by a mercury pump until no gas could be pumped off. The stopcock attached to it was then closed, arrangements being made so that if any leakage occurred it would be detected. After the flask had stood for 168 days the gas in it (5.750 c.c.) was pumped out and examined for helium with doubtful results. The flask was again closed, and on August 3, 1907, after 173 days, the gas in it was again examined. Again the presence of helium was questionable, but 1.08 c.c. of carbon dioxide was found. At the next examination, on March 30, 1908, there was distinct evidence of a helium spectrum, and the gas contained 1.209 c.c. of carbon dioxide. It was then thought possible that the carbon dioxide had been produced from the grease of the stopcock, and therefore a little mercury was introduced into the capillary tube leading to the stopcock so that the latter was protected from contact with the thorium solution. After 310 days the gas was again withdrawn. Instead of 3 c.c. or 4 c.c. no less than 180 c.c. were collected; it was almost pure nitrogen, but in all 0.622 c.c. of carbon dioxide was separated from it. These experiments, Sir William Ramsay said, rendered it at least probable that thorium engendered carbon dioxide, or, in other words, that carbon was one of its degradation products. Experiments futher indicated that the action of radium emanation on thorium nitrate solutions was also attended with the formation of carbon dioxide, and the same was the case with an acid solution of zirconium nitrate. An experiment with lead chlorate proved blank, but with bismuth perchlorate the formation of carbon dioxide appeared certain. In conclusion Sir William Ramsay, after mentioning that every precaution which could be thought of was taken to exclude foreign gas, said that while these were the facts no one was better aware than he how insufficient was the proof, and that many other experiments must be made before it could be confidently asserted that certain elements, when exposed to "concentrated energy," underwent degradation into carbon.

POISONOUS EMANATIONS FROM FERRO-SILICON

LAST December five Russian immigrants, the only steerage passengers on the steamer *Ashton* from Antwerp to Grimsby, were found dead on the arrival of the vessel at the latter port. Owing to bad weather the steerage ac-

commodations were tightly closed, while beneath was a cargo of ferro-silicon. The deaths were at first supposed to be from cholera, or possibly from ptomain poisoning, but these causes were subsequently excluded. The only noticeable symptoms found on post-mortem examination were connected with the lungs, which were in all cases strongly congested with dark venous blood. Cultures from the stomachs and intestines showed in several instances the presence of numerous vibrios, which so closely simulated those of cholera that they were with great difficulty distinguished from these. Suspicion was finally turned to the ferro-silicon as the cause of death and a series of experiments instituted which revealed the fact that under the influence of moisture poisonous gases are given off. Mice placed in jars over ferro-silicon soon showed symptoms of dulness and somnolency. When the ferro-silicon was moist, death preceded by disturbances of movement ensued in a few hours. Guinea-pigs under similar conditions succumbed in ten hours. The only abnormal feature on post-mortem examination was congestion of the lungs, such as is usually seen in cases of suffocation. Experiments were further instituted to determine what gases were responsible for the fatal results. Acetylene and hydrogen silicid were excluded and arsin found only in traces. Small quantities of phosphin (phosphoretted hydrogen) were found to be present, and this seems to be the principal poisonous constituent of the emanation. While little is known of the toxicology of phosphin, it is stated to be so poisonous that 0.02 per cent. of it in the air is fatal to small animals in half an hour. As ferro-silicon is formed by heating iron ore, quartz, coke and lime in an electric furnace, and as phosphorus is usually present in at least two of these constituents, phosphids, which evolve phosphin on treatment with water, would be present in ferro-silicon.

This investigation has served to throw light on several deaths which have been recorded in the past three years, which were undoubtedly due to ferro-silicon. In August, 1907, four persons died on the steamer *Olaf Wijk*, which was carrying ferro-silicon as part of its cargo. A short time before two children are recorded as dying on a Rhine steamer, having slept in a close cabin immediately over ferro-silicon, which composed a part of the cargo of the vessel. Four other cases of death on vessels carrying ferro-silicon are recorded, where the cause of death was not at the time suspected, but which are probably to be attributed to ferro-silicon.

As ferro-silicon is now used on a large scale in steel making, it is desirable that attention should be called to the fact that certain precautions should be taken in its transportation, especially that it shall be kept as dry as possible, and that it shall be well ventilated.

J. L. H.

SPECIAL ARTICLES

THE PHYSIOLOGICAL SIGNIFICANCE OF CREATIN AND CREATININ[1]

Two fundamental observations have furnished the incentive to investigation and given the direction to hypotheses on the topic under discussion to-day. One of these was the discovery of *creatin* as a constant constituent of the muscular tissues of vertebrates; the other was the presence of *creatinin* in the urine of the higher animals. Creatin can be changed by the action of acids into creatinin, which in turn is supposed to form creatin in alkaline solutions. Since the chemist is able so readily to convert each of these compounds into the other in the laboratory, it was quite logical for the physiologist to assume some genetic relation between them in the living body. Creatin was looked upon as a product of protein metabolism in muscle, easily converted into its "anhydride" creatinin and thus eliminated in the urine. From this point of view two possible sources of urinary creatinin early suggested themselves, namely, an *exogenous* source in the muscle tissue (meat) consumed as food; and an *endogenous* origin,

[1] Papers read at the joint session of Section K —Physiology and Experimental Medicine—of the American Association for the Advancement of Science and the bacteriologists, biochemists and physiologists, Baltimore, December, 1908.